Input parameters: TART97 updates

The following is a copy of the appendix from the TART97 documentation. TART97 extension of input parameters include,
1) New cubic and torus surfaces.
2) New spatial rotation and translation options.
3) New clone (duplicate) surface option.
4) New reduced, reflection geometry options.
5) New "in zone" source options.
6) New list of recommended sentinels.

Appendix: Summary of New Conventions and Options

To help explain and illustrate the use of the new options the TART97 CD distribution includes example input decks. I encourage you to use TARTCHEK to look at these examples - particularly using 3-D views, so you can see them better.

Biggest Changes for TART97 vs. TART96

There is no limit on input parameters. You can have any number of surfaces, zones, bounding surfaces, materials, sources, e.g., you can have a million zones, with a different material in every zone, if you want to do burnup calculations.

This also means there is no lower limit. Earlier versions of TART were dimensioned to handle large problems. Because of this the code would start at about 50 MB and then decrease in size. This caused startup problems on smaller computers. TART97 starts at about 1 MB and increases to meet the needs of your specific problem; most problems will only use 3-4 MB.

Any input line can now be continued onto any number of continuation lines. With earlier versions of TART some input, particularly complicated sources, could not be continued from one line to another, which made input preparation difficult. You will find that being able to continue any input line, it is much easier to prepare input. Some of the following new options, such as cloning, rotation and spatial translation, were recommended by TART users, and are also designed to simplify preparation of TART input. If you have ideas to even further simplify input preparation, I'd love to hear them.

The new input Options

Cubic

xcubic nb x0 y0 z0 d c b a
ycubic nb x0 y0 z0 d c b a
zcubic nb x0 y0 z0 d c b a

a cubic, rotationally symmetric about an axis - the equations are,

xcubic: $(y-y0)^2 + (z-z0)^2 = R(x)^2$
$= a(x-x0)^3 + b(x-x0)^2 + c(x-x0) + d$
ycubic: $(x-x0)^2 + (z-z0)^2 = R(y)^2$
$= a(y-y0)^3 + b(y-y0)^2 + c(y-y0) + d$
zcubic: $(x-x0)^2 + (y-y0)^2 = R(z)^2$
$= a(z-z0)^3 + b(z-z0)^2 + c(z-z0) + d$

nb	- Surface Number
x0, y0, z0	- Center coordinates
d, c, b, a	- Coordinates of the cubic

The radius along one axis is represented as a cubic. By defining zones using a cubic and planes perpendicular to the axis of the cubic, you can reproduce almost any surface, using different cubic parameters to apply along different intervals of the axis; exactly as we think in terms of performing cubic spline fits.

You can reproduce almost any surface depending on a, b, c and d - spheres, ellipses, cylinders, cones, parabola, hyperbola, plus more complicated shapes.

WARNING it is R^2, NOT R, that is represented by a cubic.

Example problem: NEWCUBIC.IN

Torus

xtorus nb x0 y0 z0 a b c
ytorus nb x0 y0 z0 a b c
ztorus nb x0 y0 z0 a b c

a torus aligned with an axis - the equations are,

xtorus: $[(x-x0)/a]^2 + [(r-c)/b]^2 = 1$
$r^2 = (y-y0)^2+(z-z0)^2$
ytorus: $[(y-y0)/a]^2 + [(r-c)/b]^2 = 1$
$r^2 = (x-x0)^2+(z-z0)^2$
ztorus: $[(z-z0)/a]^2 + [(r-c)/b]^2 = 1$
$r^2 = (x-x0)^2+(y-y0)^2$

nb	- Surface Number
x0, y0, z0	- Center coordinates
a, b, c	- Coordinates of the torus

If a =b, it is a circular torus, otherwise it is an elliptical torus.

Example problem: NEWTORUS.IN

Rotation about the X, Y or Z axis

xrotate ang is1 thru is2
xrotate ang is1 is2 is3......
yrotate ang is1 thru is2
yrotate ang is1 is2 is3......
zrotate ang is1 thru is2
zrotate ang is1 is2 is3......

A rotation of surface(s) about an axis by a clockwise angle **ang** (degrees) looking up the axis. Rotation is about the ORIGIN - not the center of the surface. Note, this differs from **surfp** and **srotate** input, which can only be used to rotate **surfr** input about the center of the surface.

ang	- angle of rotation in degrees
is1 thru is2	- rotate surface numbers is1 thru is2
is1 is2 is3...	- rotate the listed surface numbers

Surfaces can be rotated one or more times, and the rotation is cumulative and order dependent.

Any linear or quadratic surface may be rotated. Cubic and torus MAY NOT be rotated (at least yet).

WARNING - these options are executed immediately when they are read from a TART input deck. Therefore all surfaces to be rotated MUST be defined before they can be rotated, and the order of rotations is important.

WARNING - for TARTCHEK users, the lower, left hand plot, is looking at the front of your geometry in the (z,x) plane, looking UP THE Y AXIS. The upper, left hand plot, is looking down at the top of your geometry in the (z,y) plane, looking DOWN THE X AXIS. The lower, right hand plot, is looking at the right hand size of your geometry in the (y,x) plane, looking DOWN THE Z AXIS. As a result, a clockwise rotation about the y axis will appear clockwise in the lower, left hand plot. However, a clockwise rotation about the x axis will appear COUNTERCLOCKWISE in the upper, left hand plot, and a clockwise rotation about the z axis will appear COUNTERCLOCKWISE in the lower, right hand plot. This isn't an error - it is merely a result of your perspective when viewing TARTCHEK displays.

Example problems: NEWHEX.IN, NEWROT.IN (1 rotation) and NEWROT2.IN (2 rotations)

Translation of Spatial Coordinates

addxyz xadd yadd zadd is1 thru is2
addxyz xadd yadd zadd is1 is2 is3...............

Add (x,y,z) to the current center of surfaces.

xadd, yadd, zadd	- add to the current (x0, y0, z0) center coordinates of surfaces
is1 thru is2	- add to surface numbers is1 thru is2
is1 is2 is3...	- add to the listed surface numbers

Any surface may be translated, any number of times - and the results are cumulative.

This can be used to translate an entire object or objects to a new location, by translating all bounding surfaces by the same amount. It also simplifies input by allowing you to ignore the final position of a collection of surfaces, and input them as if they are at the origin - then later "add" their final center coordinates.

WARNING - these options are executed immediately when they are read from a TART input deck. Therefore all surfaces to be spatially translated MUST be defined before they can be spatially translated.

Try: Adding this to any of the example input

Cloning (Duplicating) Surfaces

clones ns is1 thru is2
clones ns is1 is2 is3.....

Clone (copy) a surface any number of times. Surface ns is copied to define surfaces is1 thru is2, or is1 is2 is3.....

ns	- surface number to clone (MUST be defined)
is1 thru is2	- make surface numbers is1 thru is2 identical to surface ns
is1 is2 is3..	- make the list of surface numbers identical to surface ns

Limitations: surface number ns MUST be defined BEFORE it can be cloned (copied). The surface numbers is1 thru is2 or is1 is2 is3... MUST NOT be defined.

Any surface may be cloned, any number of times.

This option can be used to minimize input preparation when you have a number of identical surfaces that will finally be located at different locations. You can input a surface once, clone it, and then later translate and/or rotate the clones to their final locations.

WARNING - these options are executed immediately when they are read from a TART input deck. Therefore the surface to be cloned (ns) MUST be defined before it can be cloned.

Example Problems: NEWHEX.IN, NEWROT.IN and NEWROT2.IN

Reduced, Reflecting Geometry

xabove x0
yabove y0
zabove z0

xbelow x0
ybelow y0
zbelow z0

For users who only want to model 1/2, 1/4 or 1/8 of symmetric geometry, these options can be used to: 1) define additional x, y and/or z planes, 2) add these planes as boundaries of ALL zones, 3) add additional, reflecting zones on the "other" side of the planes.

x0, y0, z0 - a plane perpendicular to the axis is defined at one of these coordinates.

"above" means transport above this plane - the reflecting zone is below this plane.

"below" means transport below this plane - the reflecting zone is above this plane.

With earlier versions of TART in order to accomplish this you had to include the surface of the reflecting zone explicitly as a bounding surface of every zone. With this new input option this is automatically done for you.

For TARTCHEK users, to see the effect of inserting these planes, use the above/below options on the "Surface" page.

WARNING: These planes are inserted into the geometry AFTER ALL input has been read - they CANNOT be rotated or transformed in ANY way. It is suggested that as a reminder to yourself, you always locate these options at the end of your TART input deck after all other geometric input parameters have been defined.

Try: Adding this to any of the example input

New Sources

These sources can be used to sample sources from irregularly shaped zones. Unlike the other sources, these sources reject a sample if it is not inside a zone number in the range nz1 through nz2. These three new sources are for a sphere, cylinder, or rectangular box. For sampling select whichever of these shapes corresponds “best” to the shape of your actual zone numbers nz1 through nz2.

RESTRICTIONS

1) nz1 MUST be less than or equal to nz2.
2) If none of 10,000 consecutive samples from the defined volume is within zone numbers nz1 through nz2, it is assumed you made a mistake and the code will terminate. This prevents the code from going into an infinite loop of sampling and rejecting forever.

source19 nz1 thru nz2 ri ro [x0 y0 z0]
s19 nz1 thru nz2 ri ro [x0 y0 z0]
s19g nz1 thru nz2 ri ro [x0 y0 z0]

A spherical shell source of inner radius ri, and outer radius ro, centered at x0, y0, z0. Use source19 or s19 for neutrons, and s19g for photons.

nz1	- lowest zone number to sample from
nz2	- highest zone number to sample from
ri	- inner radius of sphere
ro	- outer radius of sphere
x0, y0, z0	- center of the sphere (optional, defaults to 0, 0, 0)

source20 nz1 thru nz2 z1 z2 ri r0 [x0 y0]
s20 nz1 thru nz2 z1 z2 ri r0 [x0 y0]
s20g nz1 thru nz2 z1 z2 ri r0 [x0 y0]

A cylindrical shell source, aligned with the z axis, extending along the z axis from z1 to z2, of inner radius ri, and outer radius ro, centered at x0, y0. Use source20 or s20 for neutrons, and s20g for photons.

nz1	- lowest zone number to sample from
nz2	- highest zone number to sample from
z1	- lower z limit of cylinder
z2	- upper z limit of cylinder
ri	- inner radius of cylinder
ro	- outer radius of cylinder
x0, y0	- center of the sphere (optional, defaults to 0, 0)

Note, for a cylinder aligned with an axis other than the z axis, use sentl 30 (neutrons) or sentl 43 (photons) to rotate the coordinates.

source21 nz1 thru nz2 x1 x2 y1 y2 z1 z2
s21 nz1 thru nz2 x1 x2 y1 y2 z1 z2
s21g nz1 thru nz2 x1 x2 y1 y2 z1 z2

A rectangular box in (x,y,z), extending in x from x1 to x2, in y from y1 to y2, and in z from z1 to z2. Use source21 or s21 for neutrons, and s21g for photons.

nz1	- lowest zone number to sample from
nz2	- highest zone number to sample from
x1	- lower x limit of box
x2	- upper x limit of box
y1	- lower y limit of box
y2	- upper y limit of box
z1	- lower z limit of box
z2	- upper z limit of box

There are no examples of these sources included here.

Changes in sentinels

Do not limit the energy range of transport and scoring

sentl 8 and 9

These sentinels define the minimum neutron (sentl 8) and photon (sentl 9) energy below which particles cannot transport.

DO NOT use these, unless you really want to limit the minimum energy of neutrons and photons. TART will now use the minimum energy of the data read from the data files - which for neutrons differs for 175 and 650 groups.

sentl 13 and 14

These sentinels define the minimum neutron (sentl 13) and photon (sentl 14) energy below which particles cannot tally (contribute to output results).

Similar to sentl 8 and 9 above - DO NOT use these, unless you really want to limit the minimum editing energy of neutrons and photons.

sentl 15 and 16

These sentinels define the maximum neutron (sentl 13) and photon (sentl 14) energy above which particles cannot tally (contribute to output results).

Similar to sentl 8 and 9 above - DO NOT use these, unless you really want to limit the maximum editing energy of neutrons and photons. Note, soon TART will be extended to higher energies, so get used to not using these options now.

New random number sequence selection

sentl 12

The code now has 2,510 sequences, one trillion (10^{12}) samples apart. Input 0 (the default) to 2509 will use the selected sequence. Any other input is a fatal ERROR.

WARNING - this replaces the earlier definition of this sentinel, where the random number seed was entered; seen. TART95 documentation.

Highly Recommended Options

For compatibility with earlier versions of TART, by default the following options are turned off, unless the user specifies by input that they be turned on. It is Highly Recommended that you turn on ALL of the following options.

sentl 20

For neutron problems turn on resonance self-shielding. This can make problems run 20 to 30 % longer, but without accounting for self-shielding the results can be completely unreliable.

sentl 25

For photon problems turn on fluorescence. If no photons get down to low energies, this will have no effect on running time. However, if they do, this option is REQUIRED to obtain reliable answers.

sentl 39

For neutron problems turn on thermal scattering. If no neutrons get down to thermal energies, this will have no effect on running time. However, if they do, this option is REQUIRED to obtain reliable answers.